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ABSTRACT

Using the Component Display Theory as an analyzing tool, this study compared the effects of expository and discovery methods of instruction on two learning outcomes, application and transfer. One hundred ninth grade students in each of four earth science classes were randomly assigned to five groups--four experimental groups designed to test four instructional sequences and a control group. The sequences investigated were: (1) GEPG, i.e., a generality at the beginning of a lesson, followed by examples and practice exercises, and ending with a restatement of the generality (expository); (2) EP, i.e., examples followed by practice (discovery); (3) GEP, i.e., a generality first, followed by examples and then practice (expository); and (4) EPG, i.e., examples followed by practice and ending with a generality (discovery). A posttest-only control group served as the experimental design. The four treatment groups received different versions of a lesson on the concept and two basic principles of plate tectonics. Each student was given a lesson booklet and a separate booklet of figures and maps as study aids, and learning was self-paced. At the end of the lesson, they were expected to transfer this knowledge to a different situation by generating a new but related principle. Data from the 39 students who completed the activity were analyzed using analysis of variance and a 2 x 2 factorial design. No significant differences were found among the groups for either application or transfer learning, although partial support was found for one of the three hypotheses tested. (RP)

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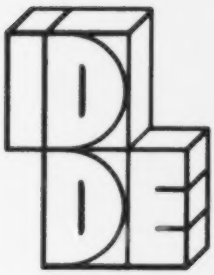

INSTRUCTIONAL DESIGN, DEVELOPMENT, AND EVALUATION

WORKING PAPERS

EFFECTS OF FOUR INSTRUCTIONAL SEQUENCES
ON APPLICATION AND TRANSFER

by

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ABSTRACT

This experimental study tested the effects of four instructional sequences (GEPG, GEP, EPG, EP) on application and transfer learning.

Data for this study came from 39 grade nine students enrolled in 4 science classes at a Syracuse public high school.

Results on application learning revealed no significant differences among the four treatment groups. However, all the group means were in the predicted order. Although these pairwise differences were not significant, the main effect for sequences with a generality first (GEPG + GEP) vs. those which had generality last only or none (EPG + EP) was significant. With respect to transfer learning, results indicated no significant differences whatsovever.

This study provides some support to the hypothesis that having a generality first (GEP or GEPG) leads to better performance on application-level learning. Since GEPG was used as an expository method as well as GEP in this study, it follows that for application learning, the expository method (GEP or GEPG) seems to lead to better performance than does either the discovery (EP) or the modified discovery (EPG) approach.

INTRODUCTION

A recent review of the literature on the effectiveness of expository and discovery methods of instruction (Keller, 1980) has shown that past research on the subject has produced inconclusive results. According to this review, the inconclusiveness has largely been due to varying interpretations given to the terms "expository" and "discovery," and to a lack of a standard framework within which to analyze instructional methods.

To correct for this deficiency, the present study used the Component Display Theory (Merrill, 1983) as a defining and analyzing tool in comparing the effects of expository and discovery methods of instruction on two learning outcomes, application and transfer.

Component Display Theory

Component Display Theory provides a language for labeling and defining the basic elements of a given piece of instruction. According to this theory, instruction can be organized (and hence, analyzed) according to (a) content type, (b) presentation form, and (c) performance level.

1. The content can either be (a) a fact, (b) a concept, (c) a principle, or (d) a procedure.

   A fact is an arbitrarily associated piece of information, such as a proper name, a date, or an event, the name of a place or the symbol used to name a particular object or event. A concept is a group of events, objects, or symbols which have common characteristics and answer to the same label. A principle is an explanation or prediction of why a given phenomenon occurs. A procedure is an order of events or a sequence of steps toward a given objective.

2. Presentation forms are either (a) primary presentation forms, or (b) secondary presentation forms.

   For application-level instruction, there are three primary presentation forms: (1) generality, (2) example, and (3) practice. A generality is a rule that defines a specific content type chosen for instruction. An example is a specific instance which has all the critical characteristics listed in the generality. Practice is a statement or question that requires the student to apply a generality to a new example. Secondary presentation forms refer to all other aspects of instruction that facilitate the processing of information or provide items of interest. These forms may be background infor-

mation on content being taught, memory aids, or types of feedback.

3. Performance levels, or levels of performance a learner is expected to exhibit as a result of instruction, can either be on a (a) remember-level, (b) use-level, or (c) find-level.

   A learner who performs at the remember-level is expected to reproduce the information that has been learned. If s/he performs at the use-level, s/he is expected to apply this information on a new, and previously unencountered, case. At the find-level, s/he is expected to invent or derive new generalities or rules based on previously learned information.

Based on this model, expository and discovery methods of instruction can thus be defined in terms of (a) the sequence of primary presentation forms, and (b) the absence or presence of a generality. An expository method is defined as having a generality at the beginning, followed by examples, then by practice. A discovery method is defined as having no generality at the beginning; it provides examples and then practice. The learning outcome "application" corresponds to use-level; "transfer," to find-level.

Previous Research

In her review of past research on the effectiveness of discovery and expository methods of instruction, Keller (1980) attributed the lack of definitive conclusions to two basic problems: inconsistencies in operationalizing the constructs "expository" and " discovery," and confounding of treatments with other instructional variables.

She found out, for instance, that the expository method has been variously labeled "lectures," "deductive learning," "teacher-centered methods," and "authoritarianism." Similarly, the discovery approach has been called "guided discovery," modified discovery," "semi-inductive discovery," "inquiry learning," and "student-centered approach." [1]

The Keller review concluded that though the revieved studies all talk of "expository" versus "discovery" methods of instruction, they actually mean different things: some may mean **delivery** of instruction (e.g. lecture versus film show-

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[1] For the specific studies included in the review, the reader is referred to Keller, F.H., Discovery and expository learning: An approach for analyzing research, 1980; and Keller, F.H. and Beigeluth, C.M., A comparison of three instructional formats, IDDE working paper no. 6, Syracuse University, 1982.

ing); others, **management** of instruction (e.g. teacher-centered versus student-centered); still others **cognitive strategies** (deductive versus inductive learning).

Partly to correct for these inconsistencies, and partly to provide a unifying tool with which to analyze instruction, Keller and Reigeluth (1982) conducted a study using the Component Display Theory as their framework for analysis. They compared the effectiveness of three instructional methods - expository, discovery, and modified discovery - on two learning outcomes, application and transfer. The expository method included the presentation of a generality first, followed by examples, then practice (GEP). The discovery method included examples and practice only (EP). The modified discovery method followed the discovery method sequence but in addition, a generality was added at the end of the lesson (EPG). Application was measured by "how well the student could use the generality presented in the lesson," while transfer was measured by "how well the student could find new generalities related to the one used in the lesson" (Keller and Reigeluth 1982, p.7).

The investigators hypothesized that for application-level learning, the GEP group would perform best, followed by the EPG and EP groups, and finally, by C (GEP>EPG=EP>C). They also hypothesized that for transfer tasks, the EPG and EP groups would perform equally well, followed by GEP, and then C (EPG=EP>GEP>C).

Results provided only partial support for these hypotheses. For application learning, contrary to predictions, the EPG mean was highest, followed by GEP, EP, and C. However, the differences were statistically significant only between EPG and EP, and between each treatment and the control. For transfer learning, although the EP mean was highest, as predicted, it still was not significantly better than the GEP group. Further, and again contrary to predictions, both GEP and EP were significantly better than EPG and C.

These results raised two basic questions:

1. In application-level learning, the EP group did the worst of the three treatment groups. Was the presence of a generality, regardless of its placement in the sequence (i.e. either first or last), more effective for application-level learning?

2. In the transfer tasks, the EPG group performed worst of the three treatment groups. Did this imply that having no generality at the end of the lesson was more effective for transfer type learning? Or was this result just a fluke, caused by the rather long generality provided to the GEP group?

Present Study

To provide some answers to these questions, the authors extended the Keller-Beigeluth study to investigate whether placing a generality at the beginning of a lesson (Generality First, or GF), or at the end (Generality Last, or GL) would affect application and transfer learning differentially. Therefore, aside from the EP, EPG, and GEP sequences used in the earlier study, a fourth sequence, GEPG, was included in this study. This sequence began with a generality, followed by examples and practice exercises, then ended with a restatement of the generality (GEPG). It was predicted that in application-level learning, a learner who was provided with a generality at the beginning and at the end of the lesson would perform better than another who only had a generality at the end; but in transfer-level learning, a learner presented with a generality first would perform worse than one who only had a generality at the end of the lesson.

Taking all four sequences into consideration, therefore, it was hypothesized that:

1. For application-level learning, the GEPG group would perform best, followed by GEP and EPG (which would perform equally well), then by EP, and finally, by C. (GEPG>GEP=EPG>EP>C)

2. For transfer-level learning, the EPG group would perform as well as EP, followed by GEP, GEPG, and C, in that order. (EPG=EP>GEP>GEPG>C)

3. For application-level learning, students using GF would perform better than those without GF; students using GL would perform slightly better than those without GL. For transfer-level learning, students without GF would perform better than those using GF; further, students without GL would perform slightly better than those using GL.

METHOD

Subjects

Since this study was designed to extend the Keller-Beigeluth study (1982), an older group of students was chosen for the present experiment. The students were freshmen at a public high school in Syracuse, New York. They were enrolled in four earth science classes, and were taught by the same teacher.

According to the teacher, most of the students were above average in intelligence and academic achievement; most of

them were white, with about 10% minority; and more than half were from middle class families.

Students in each of the four classes were randomly assigned to five groups (GEPG, GEP, EPG, EP, C). Each row in the classroom had five desks to correspond to the five groups. The experimental materials were placed on the desks before each class period in this order: GEPG, GEP, EPG, EP, and C. As the students came in, they were told to take any seat. Since this was not the usual seating arrangement in any of the classes, the authors considered the assignment to be sufficiently random.

Some 100 students participated in the study, but due to lack of time, most students did not finish the activity. As a result, usable data came from 39 students only. These 39 students were the only ones who completed the posttest. Figure 1 shows student distribution for each experimental group both before and after the incomplete data were thrown out.

Insert Figure 1 about here

Design

A posttest-only control group served as the experimental design (Campbell and Stanley, 1962).

For comparisons between the treatments and the control group, a one-way analysis of variance with five levels was performed. When significance was found, a post-hoc comparison, using the Tukey procedure, was made to determine which groups were significantly different.

For testing the third hypothesis, a 2 x 2 factorial design was used, with **Generality First (GF)** and **Generality Last (GL)** as the two factors (see Figure 2). A two-way analysis of variance was performed to examine the effects of GF and GL on student performance.

Insert Figure 2 about here

Because the mortality rate among the participants in the study was high, the authors decided to control for student ability by using the students' earth science grades from the preceding quarter as a covariate. This idea had to be dropped, however, when a correlation analysis produced extremely varied degrees of correlation, ranging from -0.28 to +0.97, across treatments and the control group.

	GEPG	GEP	EPG	EP	C
Total number of participants	20	22	19	20	19
Usable data	4	4	8	7	16

FIGURE 1

STUDENT DISTRIBUTION ACCORDING TO EXPERIMENTAL GROUPS

GENERALITY FIRST	GENERALITY LAST: NO	GENERALITY LAST: YES
NO	EP	EPG
YES	GEP	GEPG

Legend:

G = Generality
E = Example
P = Practice

FIGURE 2

2 x 2 FACTORIAL DESIGN

Instructional Task and Materials

The students in the four treatment groups were taught the concept and two basic principles of plate tectonics. At the end of the lesson, they were expected to apply the principles to new instances and to transfer this knowledge to a different situation by generating a new but related principle.

The lesson's introductory section, the examples, the practice exercises, the test items, and the maps and figures were identical for all treatment groups. For treatments using generalities, the same generalities were used. These generalities are shown in Figure 3. A breakdown of lesson components according to sequence is presented in Figure 4.

Insert Figures 3 and 4 about here

Learning was self-paced. Each student was given a lesson booklet and a separate booklet of figures and maps as study aids.

Treatments

The four treatment groups received different versions of the lesson. These versions differed in three ways: (a) presence or absence of a generality first (GEP & GEPG vs. EP & EPG); (b) presence or absence of a generality last (GEPG & EPG vs. GEP & EP); and (c) presence or absence of reinforcing cues after each example. The first two referred to the two factors (and their levels) that this study investigated. The third dealt with the amount of enrichment that accompanied each example.

Since the EPG and EP sequences fell under the discovery method of instruction and the GEPG and GEP under the expository, the presentation of the examples was systematically varied to reflect the basic difference between the discovery and exploratory approaches. For each example, a geographical phenomenon indicating a given plate movement was described, followed by a cue question. In the GEPG and GEP treatments, an answer followed each cue question; but in the EPG and EP treatments, no answer was provided. The differential amount of additional information provided to the discovery and expository groups should be seen as a necessary part of the treatments, and not as a confounding variable.

In the EPG and EP treatments, the examples and practice exercises were similarly constructed, i.e. each item included a description of a physical phenomenon and a question. The main difference was that in the examples section,

Now that we know what and where crustal plates are, let us examine two major plate movements: divergence and convergence.

o Divergence

Divergence, or spreading, begins when a plate splits and the fragmented sections are pulled away from each other. The area where the new plates are constantly pulled apart becomes the spreading, or diverging, zone.

When this spreading zone intersects a continent, the continent is stretched until it cracks. Once it does, volcanic material erupts through the fissures and pours onto the earth's surface. As the continental fragments finally separate, a new ocean basin is formed.

Spreading is accompanied by continuous volcanic activity. As the ejected lava cools off, it hardens and forms into new oceanic crust. From this gradual buildup, an underwater mountain chain, or ridge, is formed. As the ridge grows, the ocean basin widens, and continents drift further apart.

o Convergence

The second plate movement, convergence, takes place when two plates collide. When this happens, either (a) one plate is pushed down and the other overrides it, or (b) both plates rise and are welded together.

Along this zone of collision, the margin of one plate folds downwards while the margin of the overriding plate is pushed upward. The folding plate literally pushes the sea floor down into the earth's mantle, forming a trench. As the trench is forming, either of the following also takes place:

1. A volcanic island or group of islands would be formed beside the trench. Along the coast, paralleling the trench, would be mountain ranges and volcanoes.
2. If the continent stands on the colliding edge of a plate, the margins of the continent would be pushed upward till they form a mountain range. Volcanoes would dot this mountain range.

How about if the plates are welded together? Here we have a different result: as the edges of the two plates are forced upward and welded together, long mountain chains are formed all along the zone of fusion.

From the preceding discussion, it should become clear to you that:

o As a plate moves away (diverges) from another plate at one edge, it also moves toward (converges with) another plate at another edge.
o New crust is formed at spreading zones (where ridges are) while old crust is destroyed at colliding zones (where trenches are).

This entire principle explains why our earth, in spite of the so many changes it has undergone, has maintained its original size.

FIGURE 3

GENERALITY: PLATE MOVEMENTS

Components	GEPG	GEP	EPG	EP	C
• Introductory section	x	x	x	x	-
• Generality	x	x	x	-	-
• Restatement of generality	x	-	-	-	-
• Examples (n = 6)					
- with elaboration	x	x	-	-	-
- without elaboration	-	-	x	x	-
• Practice exercises (n = 5)	x	x	x	x	-
• Feedback of practice exercises	x	x	x	x	-
• Maps and illustrations	x	x	x	x	-
• Post test (n = 8)					
- application items	6	6	6	6	6
- transfer items	2	2	2	2	2

Key:

An "x" indicates the components was presented to the group.
A "-" indicates the component was not presented to the group.

FIGURE 4

LESSON COMPONENTS

the students were told that the questions were primarily designed as guide questions, to use the cues each question provided as they thought through each phenomenon, but not to bother putting their answers in writing. The two versions of an example are presented in Figure 5.

Insert Figure 5 about here

Test and Measures

The posttest had two parts: the first part measured application; the second measured transfer. In the application test, students were asked to either explain the causes of geological features or predict possible geological changes based on two principles of plate movements taught in the lesson. In the transfer test, they were asked to arrive at and use a new principle of plate movement, one that had not been covered in the lesson.

The teacher had previously reviewed these test items, as well as the examples and practice exercises, to check their level of difficulty and degree of accuracy. This was the only means of item validation that was conducted.

Administration

The lessons were given to the students during their regular earth science periods. Two classes met in the morning (first and third periods); the other two met in the afternoon (fifth and seventh periods). There were intervening class periods between all four classes. Each class period lasted for 40 minutes.

The teacher administered all the lessons. At the start of each period, he told the students that they were going to have a different learning experience, and that he would like to know how well they could learn by themselves if he did not lecture. He also told them that their performance in this class session would not contribute toward their earth science grade, and that what was being evaluated was not them, but the materials.

The students were told to study the materials on their own, and that they should finish everything (i.e. read the lesson and answer the test) within 40 minutes. They were to read the lesson booklets on their desks and use the maps and figures as study aids. As soon as they finished the practice exercises, they were to raise their hands so that a proctor (the two authors) could go to them and check their exercises. Once this was done, the proctor would collect the lesson booklet and give the student a test booklet.

Example without elaboration:

The Ascension Island lies mdiway between Africa and South America. This volcanic island is actually an exposed part of the Mid-Atlantic Ridge. It is active: geothermal waters of about 200 degrees centigrade have been encountered near its surface, and earthquakes and volcanic eruptions frequently jolt the island. Accordging to geologists, this island keeps growing.

o What causes the island to grow?

Example with elaboration:

(In addition to the paragraph and the question above, this further explanation is added:)

The fact that Ascension is actually an exposed peak of the Mid-Atlantic Ridge should have cued you in right away. Of course it is growing - the ridge stands on the boundaries of two diverging plates, so you would expect new crust to be constantly piled on it.

FIGURE 5

EXAMPLES

Those who only had a test booklet on their desks (control) were asked to complete the test first, and to raise their hands once they were done so that a proctor could collect the booklet and give them a lesson booklet.

These procedures were followed in the first two administrations, but were modified for the last two classes. To minimize the time spent distributing the test booklet, the authors decided to put the test on the desk along with the lesson booklet. When the teacher introduced the activity to the third class, he forgot to change his lines regarding the procedures for the final test. This caused some confusion, but he cleared it up right away and corrected himself.

Most students followed these instructions, although in the last class, some students were observed to proceed straight to the final test without asking for feedback on the practice exercises. Whenever the proctors spotted this, they would ask the student for the practice exercise sheet and correct it on the student's desk, providing some corrective feedback, but not the actual answer, on wrong responses.

RESULTS

Hypothesis 1: It was predicted that in application learning, GEPG would perform best, followed by both GEP and EPG (which would not differ from each other), then by EP, and finally by C. Results from the one-way ANOVA partially supported this hypothesis. The one-way ANOVA yielded an F ratio (1,34) of 2.27, significant at the .04 level (see Table 1). All the means were in the predicted order; however, the Tukey test detected no significant differences among the five groups (See Table 2).

Insert Tables 1 and 2 about here

Hypothesis 2: It was predicted that in transfer-level learning, the EPG group would perform as well as the EP group, followed by GEP, GEPG, and C, in that order. Data did not support this hypothesis. The results from the one-way ANOVA showed an F ratio (1,34) of 0.37 at a .83 significance level. Thus, no significant differences were detected among any groups. Means for transfer items are in Table 1.

Hypothesis 3: It was predicted that in application-level learning, GP groups would perform better than groups with no GP; GL groups would perform slightly better than groups with no GL. And in transfer-level learning, groups with no GP would perform better than groups with GP; further, groups with no GL would also perform slightly better than

Group	Number	Mean	SD	F(df)	PR>F
Application				2.77(4,34)	0.04*
1. GEPG	4	3.50	1.73		
2. GEP	4	3.25	0.96		
3. EPG	8	1.88	2.03		
4. EP	7	1.57	0.98		
5. Control	16	1.44	1.15		
Transfer				0.37(4,34)	0.83*
1. GEPG	4	0.50	1.00		
2. GEP	4	0.50	0.58		
3. EPG	8	0.13	0.35		
4. EP	7	0.29	0.49		
5. Control	16	0.38	0.72		

*p≤ .05

Key:

G = Generality
E = Example
P = Practice

TABLE 1

MEANS, SD, AND F-VALUES FROM ONE-WAY ANALYSIS OF VARIANCE

	Group				
	GEPG	GEP	EPG	EP	Control
Mean	3.50	3.25	1.88	1.57	1.44

Key:

Means with the same line are not significantly different.

G = Generality
E = Example
P = Practice

TABLE 2

TUKEY'S RESULTS FOR THE SIGNIFICANT MAIN EFFECT OF APPLICATION

groups with GL. The two-way ANOVA showed that in the application test, GF performed significantly better than no GF, $F(1,19)=5.83$, $p=.03$. In the transfer test, there were no significant differences for either GF, $F(1,19)=1.36$, $p=0.26$, or GL $F(1,19)=0.10$, $p=0.75$ (see Table 3). The relative effects of GF and GL on the application test are graphically portrayed in Figure 6.

Insert Table 3 and Figure 6 about here

DISCUSSION

Before drawing any conclusions, some factors that could have affected the results must first be discussed. The lesson, though previewed by the teacher, was too long for a 40-minute class period. The teacher took about 10 minutes introducing the activity. Most treatment students then spent about 20 minutes on the lesson and the practice exercises, and ended up having only 5-10 minutes for the posttest. This prevented most of them from finishing the eight-item posttest. In contrast, the control group spent about 20 minutes on the same test.

All incomplete posttests were eliminated from the data analysis, thereby reducing the number of students in each group (refer back to Figure 1). The resultant small groups could have precluded the detection of any real differences that might have existed. Eliminating the incomplete tests might have also affected the generalizability of the results. Usable data could have come solely from students with high ability (or with prior knowledge of the content). As Figure 1 indicates, the number of students who completed the GEPG and GEP versions was half that of those who completed the EPG and EP. Since the GEPG and GEP groups obtained the highest scores, it is possible that ability or prior knowledge could be responsible for the differences between the groups. However, not having a valid covariate prevented the authors from investigating and controlling for this factor.

Another factor that must be taken into account is the difference in richness between examples in GEPG and GEP and those in EPG and EP. For sequences which began with a generality, each example of a plate movement was followed by further explanation; for other sequences, no such explanation was provided. However, as mentioned in the methods section, this is a natural difference between good expository and good discovery instruction, and hence should be considered as part of the treatments rather than as a confounding variable.

Finally, one should bear in mind that the small number of items on the transfer test (n=2) likely reduced the power of

Application:

Generality First	Generality Last: No	Generality Last: Yes	
No	1.57 (0.98) 7	1.88 (2.03) 8	1.73 (1.51) 15
Yes	3.25 (0.96) 4	3.50 (1.73) 4	3.38 (1.35) 8
	2.41 (0.97) 11	2.69 (1.88) 12	

F(1,19) = 5.83
p = .03*

Interaction:
F(1, 19) = 0.00
p = .97

F(1,19) = 0.16, p = .69

Transfer:

Generality First	Generality Last: No	Generality Last: Yes	
No	0.29 (0.49) 7	0.13 (0.35) 8	0.21 (0.42) 15
Yes	0.50 (0.58) 4	0.50 (1.00) 4	0.50 (0.79) 8
	0.40 (0.54) 11	0.32 (0.68) 12	

F(1,19) = 1.36
p = .26

Interaction:
F(1,19) = 0.10
p = .75

F(1,19) = 0.10, p = .75

*p ≤ .05

TABLE 3

MEANS, (SD's), and N's FOR THE TWO-WAY ANALYSIS OF VARIANCE

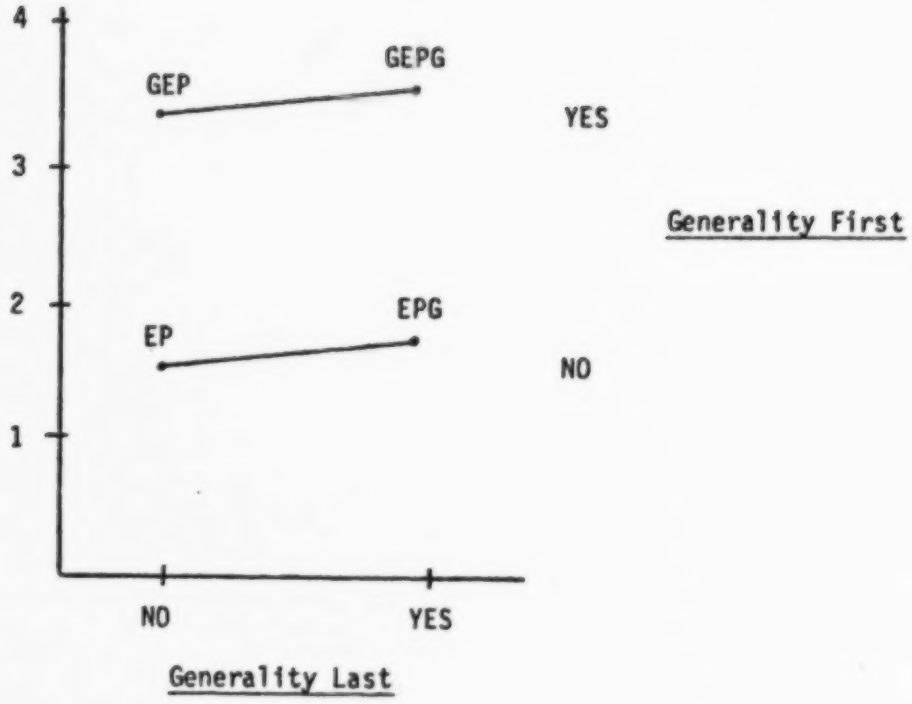

FIGURE 6

THE RELATIVE EFFECTS OF GF vs. GL ON APPLICATION

the statistical tests to detect any real differences that might have existed.

Bearing these comments in mind, we now turn to a discussion of the results. For Hypothesis 1, although the pairwise comparison revealed no significant differences among the five groups, a look at the means shows that they are in the predicted order. In addition, the means of GEPG and GEP are considerably higher than those of EPG, EF and C. On the other hand the main effect for sequences which begin with a generality (GEPG + GEP) versus those which do not (EPG + EP) is significant. This puts considerable doubt on the hypothesis that GEP and EPG are equal. Given that group sizes were so small, it is probable that the results of insignificance were due to the insufficient power which prevented the statistical procedures from detecting any real difference. Further research with larger groups is needed to answer this question.

For Hypothesis 2, no valid conclusion can be drawn. No significant differences were detected in the transfer scores at all, but this was likely due to the small number of transfer test items.

For Hypothesis 3, based on this and the Keller-Beigeluth (1982) study, the position of a generality in an instructional sequence appears to have differential effects on learning. Providing a generality at the beginning seems to result in better performance on application tasks, but providing a generality at the end does not. However, additional research is needed to validate this result because of the mortality problem discussed earlier. With respect to transfer learning, further research is likewise needed since no valid conclusion can be drawn from the present study.

If we refer back to our earlier discussion of Component Display Theory, we will see that an instructional sequence that begins with a generality (GEP or GEPG) is defined as synonymous to the expository method of instruction. It appears, therefore, that for application-level learning, students who learn through the expository method (GEP or GEPG) perform better than those who learn through the discovery (EP) or modified discovery (EPG) methods.

One final comment: A pilot test is encouraged whenever possible, since it is important in ensuring that the amount of work is appropriate for the amount of time available. The teacher's estimate may not always be accurate. In addition, a bigger pool of test items, especially for transfer-level tasks, is likewise recommended.

In conclusion, our findings seem promising, but replication is definitely needed. Extension to include long-term retention as a dependent variable would also be useful.

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